00-SM5-283
ATI-0003

REMARKS

Claims 1-45 were pending in the present application. Applicants' representative appreciates the indication that Claims 19-30 are allowed. Claim 31 has been amended, leaving Claims 1-45 for consideration in the present amendment. No new matter has been entered as a result of the amendments. For example, Claim 31 has been amended to provide proper antecedent basis to the terms "polymers and residues".

Also, attached hereto are amended Drawings, which have been amended to properly label Figures 1 and 2 in the manner suggested by the Examiner.

Reconsideration of the Drawing objection and allowance of the claims is respectfully requested in view of the above amendments and the following remarks.

Drawing Objections

Figures 1 and 2 have been amended in the manner suggested by the Examiner. Original Figure 1 has been amended to provide label Figure 1A corresponding to one micrograph and label Figure 1B corresponding to a second micrograph. Figure 2 has been amended in the same way as Figure 1. In addition, each Figure 2A and Figure 2B has been labeled as prior art. Accordingly, it is requested that the objection be withdrawn.

It is also noted that since this amendment has been filed by facsimile, it is presumed that the drawings will be of poor image quality. Applicants will send hard copies of the drawings by mail on the date of this facsimile.

Claim Rejections Under 35 U.S.C. §112

A. Claims 44 and 45 stand rejected under 35 USC §112, first paragraph, as allegedly containing subject matter which was not described in such a way as to reasonable convey to one skilled in the art that the inventors, at the time the application was filed, had possession of the claimed invention. Applicants respectfully traverse.

00-SM5-283
ATI-0003

The Office Action alleges that the claim feature "the plasma contains both electrically neutral and charged particles" was not described in the original specification. Applicants respectfully disagree. The Examiner's attention is directed to the specification, wherein it is stated that:

> The generated plasma is comprised of electrically neutral and charged particles from the gases used in the plasma gas mixture. The charged particles are selectively removed prior to plasma reaching the wafer.
>
> (Original Specification, page 10, ll. 9-11)

Thus, the specification supports the original claim language in such a manner to reasonably convey to one skilled in the art that the inventors, at the time the application was filed, had possession of the claimed invention. Accordingly, the rejection under 35 USC §112, first paragraph, should be withdrawn.

B. Claims 31-43 stand rejected under 35 USC §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. In particular, Claim 31 recited the limitation "polymers and residues", which allegedly fails to provide sufficient antecedent basis. Applicants respectfully traverse.

The above noted claim has been amended for the purpose of better defining the invention.

In view of the foregoing, Applicants respectfully request the reconsideration and withdrawal of the rejection of Claims 31-43 under 35 U.S.C. §112, second paragraph.

Claim Rejection Under 35 U.S.C. § 102(b)

Claims 1-4, 6, 9, 10 and 14-18 stand rejected under 35 U.S.C. § 102(b), as allegedly anticipated by U.S. Patent No. 5,660,682 to Zhao (hereinafter "Zhao"). Applicants respectfully traverse.

00-SM5-283
ATI-0003

Zhao is generally directed to a plasma etching and ion-based cleaning process employing plasma formed from argon and hydrogen gases. The plasma etching and ion-based cleaning process is applied to metal layers to remove undesirable materials such as oxides and polymeric photoresist. In particular, the plasma etching and ion-based cleaning process has been optimized to remove an oxide layer from the bottom of vias as well as polymeric photoresist formed on surfaces of the metal layer.

Applicants' Claim 1 is directed to a plasma ashing process for selectively removing photoresist from a semiconductor substrate including a low k material. The process comprises forming reactive species by exposing a plasma gas composition to an energy source to form a plasma, wherein the plasma is free from reactive nitrogen species and reactive oxygen species; exposing the substrate having the photoresist thereon to the reactive species after removing ions, to selectively remove the photoresist and leave the low k material substantially the same as before exposing the substrate to the reactive species.

To anticipate a claim under 35 U.S.C. § 102, a single source must contain all of the elements of the claim. *Lewmar Marine Inc. v. Barient, Inc.*, 827 F.2d 744, 747, 3 U.S.P.Q.2d 1766, 1768 (Fed. Cir. 1987), *cert. denied*, 484 U.S. 1007 (1988). Zhao fails to disclose a plasma ashing process for selectively removing photoresist from a semiconductor substrate including a low k material. First, there is no disclosure of a low k material in Zhao. Rather, Zhao is directed to a process for the removal of oxides and polymeric photoresist from patterned metal layers (*see* Col. 1, ll. 13-63), which metal layers are markedly different from low k dielectric layers. Moreover, it is submitted that Applicants' process is a plasma ashing process whereas Zhao does not disclose a plasma ashing process. Rather, Zhao discloses a plasma process that combines both etching and ion-based cleaning. The argon ions etch an oxide layer from the bottom of the vias (*see* Zhao, Col. 3, ll. 56-65, wherein "oxide is dislodged"). Dislodging oxide materials by argon and hydrogen ion bombardment is not equivalent to ashing photoresist. The etching process disclosed by Zhao is further evident by its use of a biased substrate to accelerate ions for bombardment and subsequent dislodgement (*see* Col. 3, ll. 51-59), the use of chamber pressures that are about 2-3 orders of magnitude

lower than that employed in an ashing environment (*see* Col. 3, ll. 35-39 of Zhao versus page 10, ll. 5-6 in Applicants' original application), and its disclosure that water vapor is produced (*see* Zhao, Col. 3, l. 67), which would be detrimental to low k materials (and hence the Applicants' use of an oxygen-free plasma ashing process). Etching and ashing processes are markedly different from one another, and it is believed that the etching process disclosed by Zhao would detrimentally affect the low k layer. These differences are significant and are explained in detail in Applicants' background section of the present application.

Accordingly, Applicants respectfully request withdrawal of the rejection of independent Claims 1under 35 U.S.C. § 102(b). Given that Claims 2-4, 6, 9, 10, and 14-18 depend from independent Claim 1 and include the features of the base claim, they too are patentable.

Claim Rejection Under 35 U.S.C. § 102(e)

Claims 1-6, 9, 12 and 13-18 stand rejected under 35 U.S.C. § 102(e), as allegedly anticipated by EP 1081751 A2 to Cohen et al. (hereinafter "Cohen"). Applicants respectfully traverse.

35 U.S.C. §102(e) states that:

> A person shall be entitled to a patent unless the invention was described in:
>
> (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or:
>
> (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for the purpose of this subsection of an application filed in the United States only if

00-SM5-283
ATI-0003

the international application designated the United States and was published under Article 21(2) of such treaty in the English language. [Emphasis added]

Cohen is not a proper §102(e) reference. Cohen, a published European patent application, fails to designate the United States as required by the statute. In addition, it is noted that Cohen has a publication date of July 2001 that is subsequent to Applicant's filing date of May 2001. Moreover, it is noted that Cohen has not matured into an issued patent. It is believed that the statute requires maturation into an issued patent. Accordingly, withdrawal of the rejection under 35 U.S.C. § 102 (e) of Claims 1-6, 9, 12 and 13-18 is requested.

Claim Rejection Under 35 U.S.C. § 103(a)

Claim 11 stands rejected under 35 U.S.C. § 103(a), as allegedly unpatentable over EP 1081751 A2 to Cohen et al. Applicants respectfully traverse.

Cohen was published in a foreign country on July 3, 2001. The present application has a filing date of May 14, 2001, preceding the publication date of Cohen. Accordingly, Cohen is not a proper §103 reference.

In view of the foregoing, Applicants respectfully request the withdrawal of the rejection applied to Claim 11.

It is believed that the foregoing amendments and remarks fully comply with the Office Action and place the application in condition for immediate allowance, which action is earnestly solicited.

00-SM5-283
ATI-0003

If there are any additional charges with respect to this Amendment or otherwise, please charge them to Deposit Account No. 06-1130 maintained by Applicants' Attorneys.

Respectfully submitted,

CANTOR COLBURN LLP

Date: April 9, 2003

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AMENDMENTS TO THE DRAWINGS

Approved
KBD 4/19/03

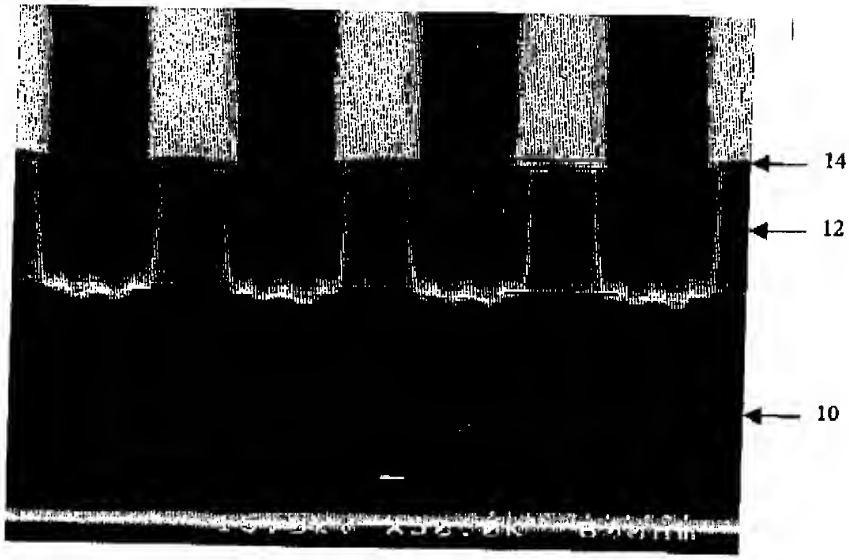
Figure 1A

Figure 1B

Approved
4/9/03
KBD

Figure 2A
(PRIOR ART)

Figure 2B
(PRIOR ART)



EFD = 5/14/01

Claims

What is claimed is:

1. A plasma ashing process for selectively removing photoresist from a semiconductor substrate including a low k material, the process comprising:

forming reactive species by exposing a plasma gas composition to an energy source to form a plasma, wherein the plasma is free from reactive nitrogen species and reactive oxygen species;

exposing the substrate having the photoresist thereon to the reactive species to selectively remove the photoresist and leave the low k material substantially the same as before exposing the substrate to the reactive species.

2. The plasma ashing process according to Claim 1, wherein the process occurs subsequent to an etching process.

3. The plasma ashing process according to Claim 1, wherein the process occurs during a rework process.

4. The plasma ashing process according to Claim 1, wherein the gas composition consists essentially of hydrogen-bearing gas and a noble gas. } H_2 + noble gas

5. The plasma ashing process according to Claim 4, wherein the noble gas is helium. } He

6. The plasma ashing process according to Claim 4, wherein the hydrogen-bearing gas is selected from the group consisting of hydrocarbons, hydrofluorocarbons, and hydrogen gas. } H_2

7. The plasma ashing process according to Claim 4, wherein the gas composition further comprises a fluorine-bearing gas.

8. The plasma ashing process according to Claim 7, wherein the fluorine bearing gas is selected from the group consisting of a compound having a formula $C_xH_yF_z$, wherein x ranges from 1 to 4, y ranges from 0 to 9 and z ranges from 1 to 10, HF, F_2 and SF_6.

9. The plasma ashing process according to Claim 1, wherein the substrate comprises a carbon and/ or hydrogen containing insulating layer having a dielectric constant less than 3.0.

10. The plasma ashing process according to Claim 4, wherein the hydrogen bearing gas is hydrogen gas.

11. The plasma ashing process according to Claim 4, wherein the hydrogen bearing gas is in an amount ranging from about 3 percent to about 30 percent by volume of the total plasma gas composition.

12. The plasma ashing process according to Claim 9, wherein the dielectric constant of the carbon and/or hydrogen containing insulating layer essentially does not change during the plasma ashing process.

13. The plasma ashing process according to Claim 1, wherein the chemical composition of the substrate essentially does not change during the plasma ashing process.

14. The plasma ashing process according to Claim 1, further comprising rinsing the substrate, wherein a critical dimension of a feature in the substrate essentially does not change during rinsing.

15. The plasma ashing process according to Claim 14, wherein the rinsing comprises wetting the substrate with an aqueous HF solution.

16. The plasma ashing process according to Claim 1, wherein the reactive species consists essentially of atomic hydrogen.

17. The plasma ashing process according to Claim 1, wherein the reactive species are selected from the group consisting of atomic hydrogen, atomic fluorine and mixtures thereof.

18. The plasma ashing process according to Claim 1, wherein the substrate further comprises a copper metal layer.

19. A post etch plasma ashing process for selectively removing photoresist, polymers and residues from a semiconductor substrate, wherein the substrate includes a layer comprising a carbon and/or hydrogen containing low k dielectric material having a dielectric constant less than 3.0, the plasma ashing process comprising:

placing the substrate including photoresist, and/or polymers and residues on the surface of the substrate into a reaction chamber;

forming reactive species by generating a plasma from a gas composition in the absence of oxygen and nitrogen,

exposing the substrate to reactive species consisting essentially of atomic hydrogen and atomic fluorine; and

selectively removing the photoresist, polymer and residues from the surface by forming volatile compounds, rinse removable compounds and mixtures thereof, wherein the surface of the substrate remains substantially unchanged during the plasma ashing process.

20. The post etch plasma ashing process according to Claim 19, wherein the gas composition consists of hydrogen gas, helium gas and fluorine bearing gas. } H_2, He & CF_4

21. The post etch plasma ashing process according to Claim 20, wherein the fluorine bearing gas comprises a tetrafluoromethane gas. } CF_4

22. The post etch plasma ashing process according to Claim 19, wherein the gas composition consists of hydrogen fluoride gas. } HF

23. The post etch plasma ashing process according to Claim 19, wherein the hydrogen gas is in an amount ranging from about 1 percent to about 99 percent of the total gas composition. } H_2 = 1-99% of total Vol.

24. The post etch plasma ashing process according to Claim 19, wherein the hydrogen gas is in an amount ranging from about 3 percent to about 30 percent of the total gas composition.

25. The post etch plasma ashing process according to Claim 19, wherein the hydrogen gas is in an amount ranging from about 1 percent to about 5 percent of the total gas composition.

26. The post etch plasma ashing process according to Claim 19, wherein an ashing selectivity between the photoresist and the substrate is greater than 50 : 1.

27. The post etch plasma ashing process according to Claim 19, wherein the dielectric constant of the carbon and/or hydrogen containing insulating layer essentially does not change during the plasma ashing process.

28. The post etch plasma ashing process according to Claim 19, wherein the chemical composition of the low k dielectric material essentially does not change during the plasma ashing process.

29. The post etch plasma ashing process according to Claim 19, further comprising rinsing the substrate, wherein a critical dimension of a feature on the substrate essentially does not change during rinsing.

30. The post etch plasma ashing process according to Claim 29, wherein the rinsing step comprises wetting the substrate with an aqueous HF solution.

31. A method of manufacturing a microelectronic device, the method comprising:

forming a photoresist mask on a surface of a semiconductor substrate, wherein the substrate includes a carbon or a hydrogen containing low k dielectric layer;

etching and removing portions of the substrate through openings in the photoresist mask to permanently transfer an image into the substrate and expose a surface of the low k dielectric layer; and

ashing the photoresist mask, polymers and residues from the substrate with a plasma generated from a gas mixture consisting of hydrogen, helium and tetrafluoromethane to selectively remove the mask and residues from the substrate.

32. The method according to claim 31, wherein the low k dielectric layer has a dielectric constant less than 3.0.

33. The method according to claim 31 wherein the carbon-containing low k dielectric layer comprises a polymer having a backbone containing carbon.

34 The method according to claim 31 wherein the carbon-containing dielectric layer comprises a carbon doped oxide.

35 The method according to claim 31wherein the plasma contains from about 1 percent to about 99 volume percent of hydrogen in the gas mixture.

36 The method according to claim 31 wherein the plasma contains from about 10 percent to about 30 volume percent of hydrogen in the gas mixture.

37 The method according to claim 31, wherein the plasma contains from about 1 percent to about 5 volume percent of hydrogen in the gas mixture.

38 The method according to claim 31 further comprising removing the photoresist mask with the plasma at a temperature less than about 450°C and a pressure less than about 6 torr.

39. The plasma ashing process according to Claim 31, further comprising rinsing the substrate subsequent to ashing the photoresist from the substrate, wherein a critical dimension of the image in the substrate essentially does not change during rinsing.

40. The plasma ashing process according to Claim 39, wherein the rinsing step comprises wetting the substrate with an aqueous HF solution.

41. The plasma ashing process according to Claim 31, wherein the ashing step consists essentially of exposing the substrate to atomic hydrogen, atomic helium and atomic fluorine species.

42. The plasma ashing process according to Claim 31, wherein the ashing step consists essentially of exposing the substrate to atomic hydrogen, and atomic helium species.

43. The plasma ashing process according to Claim 31, wherein the etch residues comprise sidewall polymers formed during the etching step.

44. A plasma ashing process for selectively stripping photoresist and/or polymers and residues from a surface of a substrate, the method comprising:

placing a substrate having a photoresist mask thereon into a reaction chamber;

generating a plasma from a gas mixture consisting of hydrogen, helium and tetrafluoromethane, wherein the plasma contains both electrically neutral and charged particles;

substantially removing the charged particles from the plasma;

exposing the substrate and photoresist mask to the electrically neutral species in the plasma, wherein the substrate exposed to the plasma includes a carbon and/or hydrogen containing low k dielectric material; and

ashing the photoresist mask to selectively remove the mask from the substrate, wherein the chemical composition of the low k dielectric layer is substantially the same as before the step of exposing the substrate to the plasma.

45. A plasma ashing process for selectively stripping photoresist and/or polymers and residues from a surface of a substrate, the method comprising:

placing a substrate having a photoresist mask thereon into a reaction chamber;

generating a plasma from a gas mixture consisting of hydrogen and helium, wherein the plasma contains both electrically neutral and charged particles;

substantially removing the charged particles from the plasma;

exposing the substrate and photoresist mask to the electrically neutral species in the plasma, wherein the substrate exposed to the plasma includes a carbon and/or hydrogen containing low k dielectric material; and

ashing the photoresist mask to selectively remove the mask from the substrate, wherein the chemical composition of the low k dielectric layer is substantially the same as before the step of exposing the substrate to the plasma.